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NOTES ON THE GEOLOGY OF GEORGIA

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Atlanta, Georgia

ARCHEAN SYSTEM

The geological history of Georgia begins with the ancient Crystalline rocks, the greater part of which are supposed to be of Archean age. These rocks form a northeast-southwest belt about 125 miles wide traversing the northern part of the state and are a part of the great belt of ancient Crystallines extending from northeastern New York to eastern Alabama (Fig. 1). The areal extent in Georgia is about 15,000 square miles, or approximately one-fourth of the state. They occupy all of the physiographic division known as the Piedmont Plateau, and a part of the Appalachian Mountain division. To the northwest they are limited by the metamorphic Cambrian rocks and to the south by the Tertiary. The latter boundary is sharp and distinct, while the former is ill-defined. These rocks are here described under the following names: Carolina gneiss, Roan gneiss, and granites.

The *Carolina gneiss*, so called from its wide distribution in the Carolinas, where it has been studied by Keith and others, is the prevailing rock of the ancient Crystallines of Georgia (Fig. 2). Broadly speaking, the formation may be correlated with the Baltimore gneisses of Maryland and the Stanford and Fordham gneisses of New York.

The most abundant, widespread, and typical rocks of the Carolina formation are schists, largely micaceous and garnetiferous, and biotite gneiss. In addition there occur in more or less restricted areas graphitic schist, quartzitic schist, and schistose conglomerate. The most persistent character of these rocks is the schistose and bended structure due to the segregation of the component minerals along definite lines. They are the oldest rocks of the state and may be considered the country rock into which the Roan gneiss and

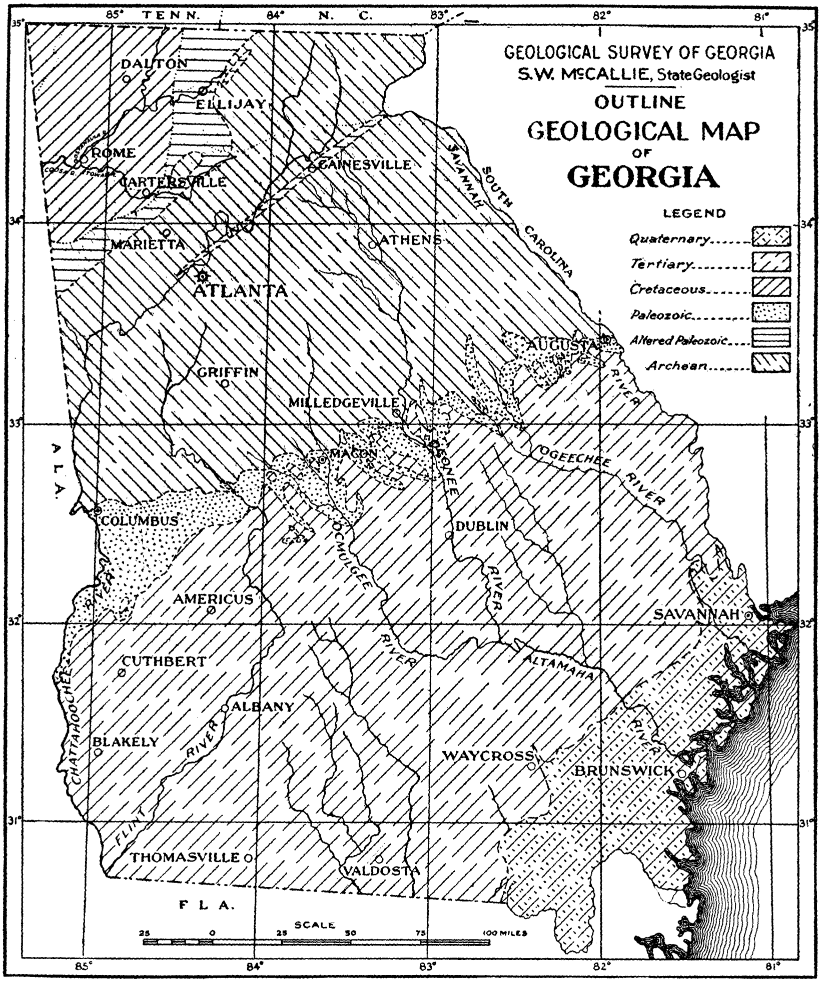
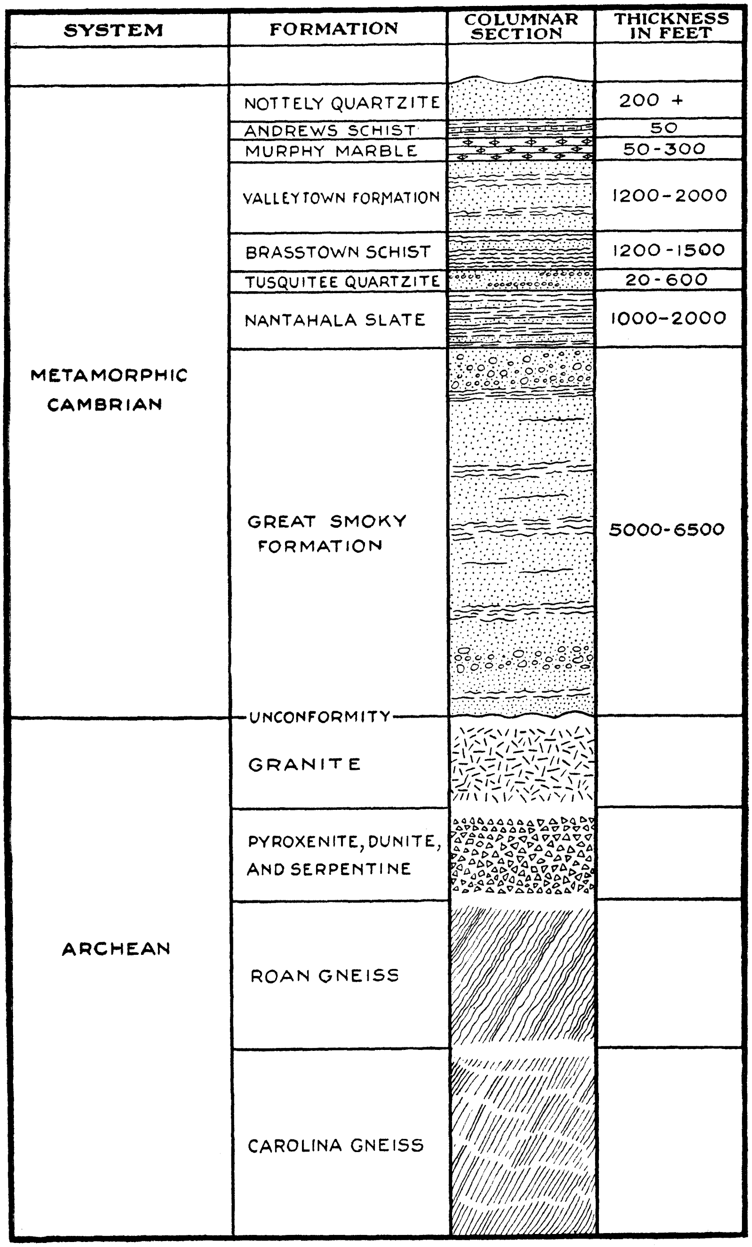

GEOLOGICAL SURVEY OF GEORGIA
S.W. McCALLIE, State Geologist
OUTLINE
GEOLOGICAL MAP
OF
GEORGIA
LEGEND
Quaternary
Tertiary
Cretaceous
Paleozoic
Altered Paleozoic
Archean
TENN.
N. C.
SOUTH CAROLINA
ALA.
FLA.
DALTON
ELLIJAY
ROME
CARTERSVILLE
GAINESVILLE
MARIETTA
ATLANTA
ATHENS
AUGUSTA
GRIFFIN
MILLEDGEVILLE
MACON
COLUMBUS
DUBLIN
AMERICUS
SAVANNAH
CUTHBERT
ALBANY
BLAKELY
WAYCROSS
BRUNSWICK
THOMASVILLE
VALDOSTA
SAVANNAH RIVER
OGEECHEE RIVER
OCONEE
OCMULGEE RIVER
ALTAMAHA RIVER
FLINT RIVER
CHATTAHOOCHEE RIVER
SCALE
25 0 25 50 75 100 MILES
85° 84° 83° 82° 81°
35° 34° 33° 32° 31°

Fig. 1

COLUMNAR SECTION

ALTERED PALEOZOIC AND ARCHEAN ROCKS OF GEORGIA



SYSTEM	FORMATION	COLUMNAR SECTION	THICKNESS IN FEET
METAMORPHIC CAMBRIAN	NOTTELY QUARTZITE		200 +
	ANDREWS SCHIST		50
	MURPHY MARBLE		50-300
	VALLEYTOWN FORMATION		1200-2000
	BRASSTOWN SCHIST		1200-1500
	TUSQUITEE QUARTZITE		20-600
	NANTAHALA SLATE		1000-2000
	GREAT SMOKY FORMATION		5000-6500
	UNCONFORMITY		
ARCHEAN	GRANITE		
	PYROXENITE, DUNITE, AND SERPENTINE		
	ROAN GNEISS		
	CAROLINA GNEISS		

FIG. 2

granites have been intruded. The series is supposed to be largely of igneous origin, though sediments undoubtedly occur in certain localities, as shown by the graphitic schist, quartzitic schist, and schistose conglomerate.

The *Roan gneiss* is a series of basic igneous rocks including hornblende schist, hornblende gneiss, and schistose diorite. These rocks occur in belts varying from a few feet to hundreds of rods in width and often cut the Carolina gneiss, into which they have been intruded at rather high angles. Less abundant and only locally developed are pyroxenites, dunites, and serpentine belonging to the same series.

The *granites* are widely distributed and in places cover areas of many square miles. They are prevailingly biotitic and generally show gneissic structure. In age they are supposed to be largely pre-Cambrian, though the more massive varieties, such as Stone Mountain near Atlanta, are probably younger. The granites unquestionably represent two or more periods of intrusion.

CAMBRIAN SYSTEM

ALTERED CAMBRIAN

The Cambrian system is divided into the altered and unaltered Cambrian. The altered or metamorphic Cambrian rocks, so far as known, are mainly confined to an irregular belt, varying in width from eight to twenty-five miles, in the northwestern part of the state. The belt lies immediately west of the Archean rocks and embraces in its northern extension a greater part of the Appalachian Mountain physiographic division of the state. These rocks belong to the Ocoee group of Safford and were long regarded as of Algonkian age. However, fossils of Lower Cambrian age are found as far down as the middle of this group of strata in Tennessee and North Carolina, and the strata below the fossil-bearing beds are conformable and not materially different in character. In addition to this main belt there is a narrow belt known as the Brevard schist entering the state from South Carolina northeast of Gainesville and stopping about five miles west of Atlanta. It seems quite probable that the metamorphic Cambrian originally overlay the Crystallines as far east as Atlanta and possibly beyond.

This group of altered sediments has been studied in detail only in one section of the state, namely, the area covered by the *Ellijay Folio*. In that locality the rocks have been described by La Forge and Phalen under the following formation names: (1) Great Smoky formation, (2) Nantahala slate, (3) Tusquitee quartzite, (4) Brasstown schist, (5) Valleytown formation, (6) Murphy marble, (7) Andrews schist, and (8) Nottely quartzite.

The *Great Smoky formation*, in the Ellijay quadrangle along its eastern margin, lies upon the Carolina gneiss, although the immediate contact is difficult to define, as in that section the latter is made up largely of graywacke and conglomerate, which are very similar in lithological character to the base of the Great Smoky. The formation consists of a great thickness of conglomerate, graywacke, sandstone, quartzite, slate, mica schist, garnet schist, and staurolite schist. The conglomeratic phase is best developed to the east and north, while to the west and south the mica schist, quartzite schist, and slates prevail. The Great Smoky formation is a part of Safford's Ocoee series and has been provisionally correlated with the Cochran and the Thunderhead conglomerates of Tennessee and North Carolina. West of the Ellijay quadrangle and below the Great Smoky formation occur considerable areas of the Wilhite slate and the Gilmer formation, but their detailed structure and relations have not yet been worked out.

The *Nantahala slate*, near the Georgia-North Carolina line, includes principally blackish and dark-gray slates, though white quartzite and staurolitic schist are also more or less plentiful. Farther south in the vicinity of Ellijay and beyond, the formation is mainly graphitic schist with but few siliceous beds. Its distribution is confined to the eastern margin of the metamorphic area, where it forms narrow belts rarely over a mile in width.

The *Tusquitee quartzite*, which is apparently confined to the Ellijay quadrangle, consists almost entirely of white quartzite with an occasional bed of conglomerate. Owing to the persistent character of the formation and its difference in color from the associated rock, it is an excellent guide in working out the stratigraphy of the region, which is much complicated by numerous faults and folds.

The *Brasstown schist*, where not displaced by faulting, has a similar distribution to the Tusquitee quartzite, though it does not extend so far south as the latter. It is made up of banded slate and ottrelite schist having usually a dark, bluish color. Owing to its limited distribution it is only of minor stratigraphic importance.

The *Valleytown formation* consists of biotite schists, sericite schist, and mica gneiss, with a few beds of quartzite and conglomerate. In the Ellijay quadrangle south of Cherrylog it is described as a nearly homogeneous mass of sericite, mica schist, and siliceous slate, with some talcose material. The occurrence of graphitic schist beds are noted in the formation between Toccoa River and Ellijay. The formation is usually valley-forming, though north of Blue Ridge, extending to the state line, it forms a rather prominent ridge, as well as the narrow valleys on either side.

The *Murphy marble*, from an economic standpoint, is the most important of the metamorphic group of rocks in the state. It consists of holocrystalline limestone which in places becomes magnesian. The magnesian phase of the formation is commonly fine-grained, while the high-calcium phase is coarse-grained. It is usually white but in places is more or less banded or mottled with black owing to the presence of graphite. The formation enters the state from North Carolina in the vicinity of Culberson, from which point it continues southwest in one or more narrow belts, with a few interruptions due to faulting, to a point a few miles beyond Tate, Pickens County, the seat of Georgia's great marble industry. Marble very similar in texture and composition occurs many miles farther to the southwest in Haralson County, near Buchanan, which is supposed to be the southern extension of the Murphy marble. The formation is probably the equivalent of the Shady limestone, an unaltered magnesian limestone hereafter to be described.

The *Andrews schist* is a comparatively thin, unimportant calcareous schist overlying the Murphy marble near the Georgia-North Carolina line, and like the overlying Nottely quartzite is of very limited extent. It is made up almost entirely of dense quartzite which is highly resistant to weathering and is therefore ridge-forming.

UNALTERED CAMBRIAN

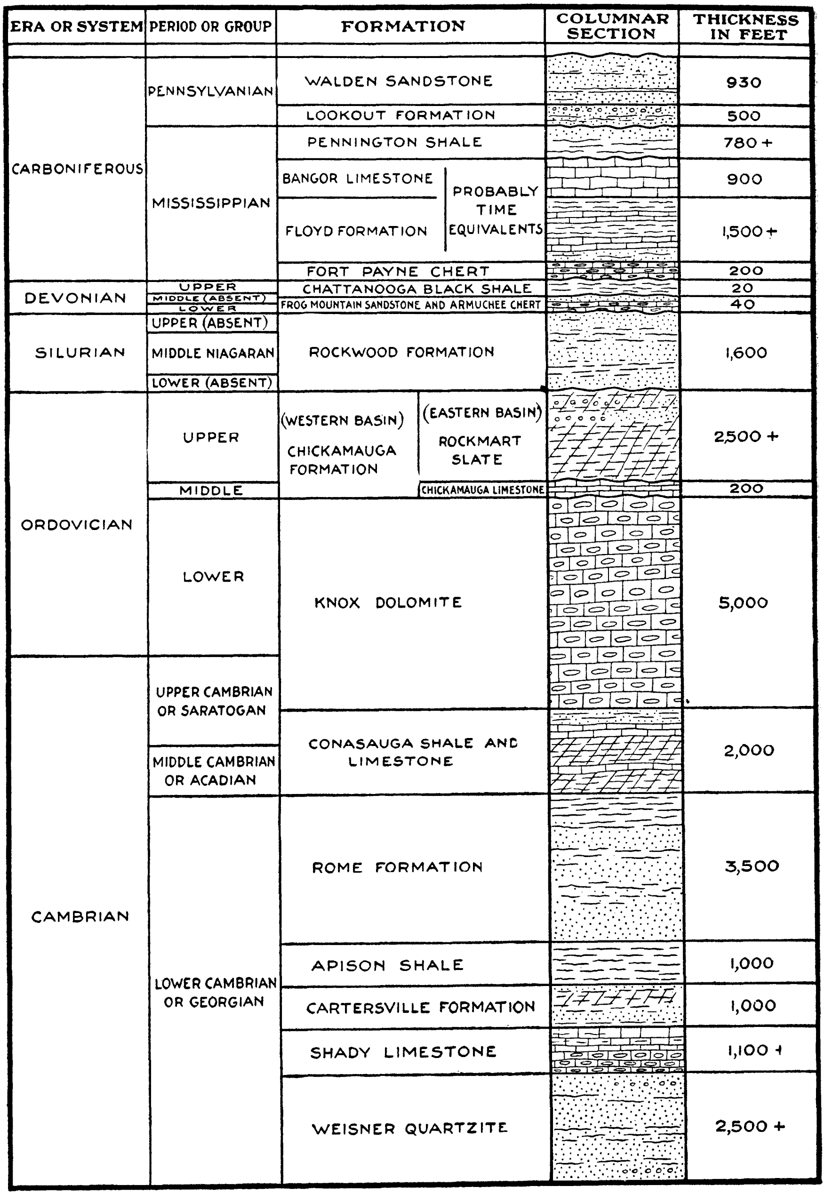
The Unaltered Cambrian rocks occupy the northwestern part of the state and are divided into the Lower, the Middle, and the Upper divisions, the first named being subdivided into the Weisner quartzite, Shady limestone, Cartersville formation, Apison shale, and Rome formation (Fig. 3).

The *Weisner quartzite*, which is the southern extension of a part of the Chilhowee sandstone of Tennessee, forms a prominent series of ridges and hills along the eastern margin of the Appalachian Valley as far south as Cartersville and a few miles beyond. At this point it is cut out by the Cartersville fault, but farther to the southwest it again appears in a small area near Esom Hill, where it forms the northern extension of a large area just across the state line in Alabama. The lithological character of the Weisner quartzite as described by Hayes is fine-grained and vitreous, though the formation also contains some beds of fine conglomerate and considerable siliceous shale. A few imperfectly preserved fossil remains, including brachiopods, corals, and worm tubes, all supposed to be Lower Cambrian, have been found in the formation in the vicinity of Cartersville and Emerson.

The *Shady limestone* lies immediately above the Weisner quartzite, and it has a like distribution. The formation consists chiefly of gray magnesian limestone usually massive but in places shaly and siliceous. It is of very great economic importance, as associated with its weathered product, occur more or less extensive deposits of barytes, iron ore, and manganese ore. Fossils are almost entirely absent, though in the vicinity of Cartersville a fossil sponge, a lower Cambrian form, has been found.

The *Cartersville formation*, as recently defined by Shearer, is known only in the Cartersville district. It is supposed to occupy the same position in the stratigraphic column as the Watauga shale of Tennessee and the Apison shales of Tennessee and Georgia. The formation has a limited distribution, being confined to one main belt less than twenty miles long. It consists mainly of highly aluminous shales, which are remarkable for their high potash contents, often as much as 10 per cent K_2O. Associated with the shales, which are chiefly of a gray or purplish color, there are often

COLUMNAR SECTION
PALEOZOIC ROCKS OF GEORGIA



ERA OR SYSTEM	PERIOD OR GROUP	FORMATION	COLUMNAR SECTION	THICKNESS IN FEET
CARBONIFEROUS	PENNSYLVANIAN	WALDEN SANDSTONE		930
		LOOKOUT FORMATION		500
	MISSISSIPPIAN	PENNINGTON SHALE		780 +
		BANGOR LIMESTONE PROBABLY TIME EQUIVALENTS		900
		FLOYD FORMATION		1,500 +
		FORT PAYNE CHERT		200
DEVONIAN	UPPER	CHATTANOOGA BLACK SHALE		20
	MIDDLE (ABSENT)			
	LOWER	FROG MOUNTAIN SANDSTONE AND ARMUCHEE CHERT		40
SILURIAN	UPPER (ABSENT)	ROCKWOOD FORMATION		1,600
	MIDDLE NIAGARAN			
	LOWER (ABSENT)			
ORDOVICIAN	UPPER	(WESTERN BASIN) CHICKAMAUGA FORMATION (EASTERN BASIN) ROCKMART SLATE		2,500 +
	MIDDLE	CHICKAMAUGA LIMESTONE		200
	LOWER	KNOX DOLOMITE		5,000
CAMBRIAN	UPPER CAMBRIAN OR SARATOGAN	CONASAUGA SHALE AND LIMESTONE		2,000
	MIDDLE CAMBRIAN OR ACADIAN			
	LOWER CAMBRIAN OR GEORGIAN	ROME FORMATION		3,500
		APISON SHALE		1,000
		CARTERSVILLE FORMATION		1,000
		SHADY LIMESTONE		1,100 +
		WEISNER QUARTZITE		2,500 +

FIG. 3

found thin layers of feldspathic sandstone and quartzite, but these form only a minor part of the formation as a whole.

The *Apison shale* consists of varicolored argillaceous shales developed only in limited, elongated areas in Whitfield and Catoosa counties. Although the Apison is evidently approximately equivalent to the Cartersville formation in age, the exposures are in the western part of the valley.

The *Rome formation* consists of sandstone and shale and is confined to two belts near the center of the Appalachian Valley. The main belt, which is rarely more than two miles wide, extends from near Cave Spring, Floyd County, northeast through Rome to a point within about three miles northwest of Calhoun in Gordon County. The other belt commences near Villanow in Walker County and continues to the Georgia-Tennessee line a few miles northeast of Ringgold. A third belt which Hayes placed in this formation on the basis of stratigraphic position is above described as the Cartersville formation. Immediately overlying the Rome formation and apparently without any stratigraphic break are the only representatives of Upper Cambrian, namely the Conasauga formation and the lower division of the Knox dolomite formation.

The *Conasauga formation*, with the exception of the Knox dolomite, covers the largest surface area of any of the Cambrian series of Georgia. It is especially well developed along the eastern side of the Appalachian Valley, where it occurs in two main elongated but broad belts. The easternmost of these belts continues south from the Georgia-Tennessee line from Tennga to a point a few miles south of Cartersville, where it is cut off by the Cartersville fault, while the other belt, after being divided into minor belts and at points uniting with the easternmost belt, continues to the Alabama state line by way of Rome. Farther to the west are three narrow belts, one of which, lying to the west, traverses the entire northwestern corner of the state by way of Lafayette. The upper part of the formation is made up largely of olive-green and yellowish-green argillaceous shale, but the lower part consists mainly of grayish and bluish limestones locally oölitic and interstratified with the shale. The Conasauga formation contains an abundant Cambrian fauna which has been studied by Professor C. D. Walcott.

The *Knox dolomite* is divided by an unconformity into a lower and upper division. The upper division on paleontological evidence has been referred to the Ordovician system and the lower to the Cambrian. The formation as a whole consists of a great thickness of magnesian limestones with much chert in places. It occurs in a large number of broad and narrow belts traversing the Appalachian Valley.

ORDOVICIAN SYSTEM

The *Chickamauga formation* represents both the Middle and the Upper group of the Ordovician system. It consists of sediments laid down in two separate basins. The rocks in the western part of the valley consist of interbedded limestones and shales outcropping in a number of long, narrow belts, while in the eastern part of the valley the formation is divided into the Chickamauga limestone and the Rockmart slate. The latter consists chiefly of dark-colored slates, with a few thin beds of sandstone and some limestone usually high in calcium.

SILURIAN SYSTEM

The *Rockwood formation*, which unconformably overlies the Chickamauga formation, is the only representative of the Silurian system. It consists of olive-green shales and thin-bedded sandstone, with one or more beds of fossiliferous iron ores. It occurs only in the western part of the Appalachian Valley, where it forms narrow belts at the base of the higher ridges and mountains capped with Carboniferous rock.

DEVONIAN SYSTEM

The *Chattanooga black shale* and the *Armuchee chert* are the only representatives of the Devonian system in Georgia. These two formations are separated from each other by an unconformity and are supposed to represent the Upper and Lower Devonian respectively, the middle part of the system being absent. The black shale, which attains a thickness of not more than twenty feet, is confined to the western part of the valley, where it occurs in narrow outcrops with a linear distribution coextensive with the Rockwood formation. The Armuchee chert, which consists of bedded chert and thin beds of reddish-brown sandstone, is confined to a few small areas north of Rome.

CARBONIFEROUS SYSTEM

The *Fort Wayne chert* is the lowest member of the Mississippian group of the Carboniferous system and unconformably overlies the Chattanooga black shale. It consists essentially of siliceous limestone, with layers and nodules of chert made up in places largely of crinoid stems. The formation in the western part of the Appalachian Valley occupies narrow belts, while north of Rome it covers large, irregular areas.

The *Floyd shale* and the *Bangor limestone*, which also belong to the Mississippian group are probably stratigraphically equivalent, though one is largely shale and the other limestone. The former is best developed along the narrow valleys at the base of Lookout and Sand mountains, while the other occurs in numerous narrow belts in Floyd County and the adjacent counties both north and east of Rome.

The *Pennington shale* unconformably overlies the Bangor limestone and forms the uppermost series of the Mississippian group. It consists largely of shale, with sandstone in the upper portion. Its linear distribution is coextensive with the Bangor limestone.

The *Lookout formation* and the *Walden sandstone* are both members of the Pennsylvanian group. They are best developed in Lookout and Sand mountains, which constitute what is known as the Cumberland Plateau physiographic division of the state. They consist of sandstones, conglomerates, shales, and a number of commercial coal seams.

CRETACEOUS SYSTEM

The Cretaceous system, which rests unconformably on the old crystalline rocks, is confined to a narrow, irregular belt traversing the middle portion of the state in a southwest direction from Augusta to Columbus by Milledgeville and Macon. The total area covered by this system of rocks is approximately 250 square miles. It is divided into an upper and a lower series, the latter being further divided into two formations, namely the Ripley and the Eutaw (Fig. 4).

The *Lower Cretaceous*, so far undifferentiated, lies immediately upon the crystalline rocks below and is unconformably overlain by the Eutaw. The basal unconformity represents an enormous time interval, including all Paleozoic time and the Triassic[1] and Jurassic periods of the Mesozoic time. The formation is made up predominantly of coarse-grained cross-bedded, arkosic sand, with a subordinate amount of white clays in the form of lenses. It forms an irregular belt varying from two to ten miles in width and extending entirely across the state.

The *Eutaw and Ripley formations*, each divided into two or more members, occupy an elongated area immediately south of the Lower Cretaceous between the Ocmulgee and Chattahoochee rivers. Both formations are of marine origin and consist mainly of calcareous, micaceous sand and dark-gray sandy clay, with some thin-bedded impure limestone. The upper member of the Ripley formation is unconformably overlain by the Midway formation, the basal member of the Eocene series.

TERTIARY SYSTEM

The Tertiary system of rocks has a far greater areal extent than any other system in the state. With the exception of a narrow belt of Quaternary along the Atlantic seaboard and narrow irregular belts of Cretaceous immediately south of the ancient Crystallines, it covers the entire Coastal Plain which comprises more than one-half the area of the state. The system is represented by the following series: the Eocene, the Oligocene, the Miocene, and the Pliocene. The first named is divided into five formations, the Midway, the Wilcox, the McBean, the Ocala, and the Keg Creek. The Keg Creek and the Ocala limestone formations both belong to the Jackson group, while the McBean formation belongs to Claiborne group.

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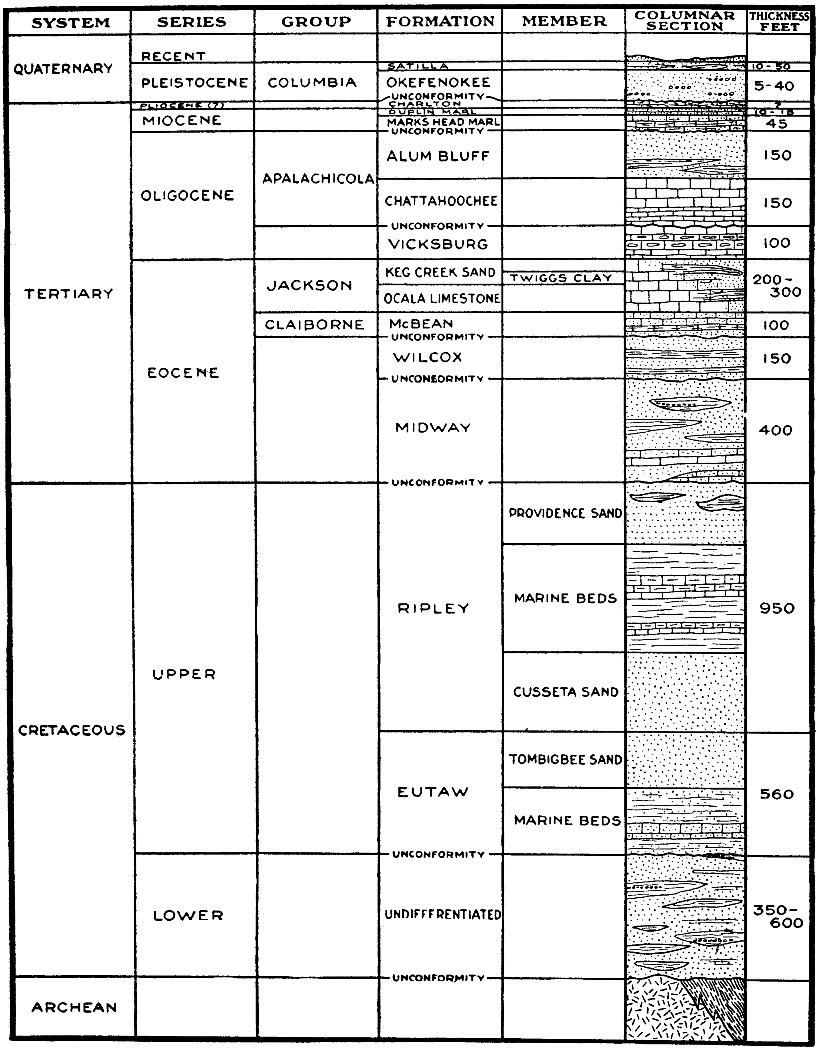
[1] The Triassic rocks in Georgia are represented by diabase dikes which are widely distributed over the Piedmont Plateau.

COLUMNAR SECTION
COASTAL PLAIN OF GEORGIA



SYSTEM	SERIES	GROUP	FORMATION	MEMBER	COLUMNAR SECTION	THICKNESS FEET
QUATERNARY	RECENT					
	PLEISTOCENE	COLUMBIA	SATILLA			10-50
			OKEFENOKEE			5-40
			UNCONFORMITY			
TERTIARY	PLIOCENE (?)		CHARLTON			?
	MIOCENE		DUPLIN MARL			10-15
			MARKS HEAD MARL			45
			UNCONFORMITY			
	OLIGOCENE	APALACHICOLA	ALUM BLUFF			150
			CHATTAHOOCHEE			150
			UNCONFORMITY			
			VICKSBURG			100
	EOCENE	JACKSON	KEG CREEK SAND	TWIGGS CLAY		200-300
			OCALA LIMESTONE			
		CLAIBORNE	McBEAN			100
			UNCONFORMITY			
			WILCOX			150
			UNCONFORMITY			
			MIDWAY			400
			UNCONFORMITY			
CRETACEOUS	UPPER		RIPLEY	PROVIDENCE SAND		950
				MARINE BEDS		
				CUSSETA SAND		
			EUTAW	TOMBIGBEE SAND		560
				MARINE BEDS		
			UNCONFORMITY			
	LOWER		UNDIFFERENTIATED			350-600
			UNCONFORMITY			
ARCHEAN						

FIG. 4

EOCENE SERIES

The *Midway formation*, which forms the base of the Eocene series, lies unconformably upon the upper member of the Cretaceous and is unconformably overlain by the Wilcox. It consists of sand, clay, and marl, and forms a narrow northeast-southwest belt extending from Fort Gaines on Chattahoochee River to a point a short distance east of Flint River in Houston County. At no place does it exceed twelve miles in width.

The *Wilcox formation* has a distribution similar to the Midway, though it probably does not extend beyond Flint River. It is made up mainly of sandy, glauconitic shell marl and laminated, sandy, dark-colored lignitic clay. Near Flint River pure beds of white clay occur, with red and varicolored sand.

The *McBean formation* forms an extremely irregular belt which varies from two to thirty miles or more in width and extends entirely across the state. East of Ocmulgee River it rests unconformably on the strata of Lower Cretaceous age, while between Flint and Chattahoochee rivers it rests unconformably upon the Wilcox formation. It consists of shell marl, sandy limestone, glauconitic, calcareous sands, and clays in the form of fuller's earth.

The *Ocala limestone*, which is best developed between Ocmulgee and Chattahoochee rivers, is the main representative of the Jackson group in Georgia. Its eastern boundary lies usually a few miles west of Flint River, whence it extends south and west as a broad belt to the Georgia-Alabama-Florida state line, with an average width of more than thirty-five miles. The formation, as the name suggests, is made up of limestone with more or less chert in places.

OLIGOCENE SERIES

The *Oligocene series* is represented by the Vicksburg, the Chattahoochee, and the Alum Bluff formations, subdivisions of the Appalachicola group. The three formations are confined largely to the southern part of the Coastal Plain near the Georgia-Florida state line and to irregular areas southeast and southwest of Macon. The Vicksburg and the Chattahoochee formations, which are separated by an unconformity, consist largely of limestone, while the Alum Bluff formation is made up mainly of sands and clays.

MIOCENE SERIES

The *Marks Head Marl* and the *Duplin marl* are the only formations belonging to the Miocene series. These two formations, which are best developed at Porters Landing on Savannah River, consist mainly of marls, sands, and clays. The Marks Head marl unconformably overlies the Alum Bluff formation.

PLIOCENE SERIES

The *Charlton formation*, which is supposed to belong to the Pliocene series, occurs along St. Marys and Satilla rivers in the extreme southern part of the state. The formation consists mainly of shell marls.

The *Altamaha* (*Lafayette ?*) *formation*, not shown in the columnar section, has the greatest areal extent of any formation in the Coastal Plain, covering approximately 21,000 square miles. Like the underlying Charlton formation, it is supposed to be Pliocene. The formation has a maximum thickness of less than three hundred feet and consists chiefly of sand, gravel, and clay, which in places become indurated. With the exception of a few fragments of wood it is entirely free from organic remains.

QUATERNARY SYSTEM

PLEISTOCENE SERIES

The Pleistocene is represented by the Okefenokee and the Satilla formations, divisions of the Columbia group. These formations form a belt along the Atlantic Coast, with a width from twenty to fifty miles. The Okefenokee consists chiefly of gray sand, and the Satilla is made up of greenish and bluish marine clays and gray and yellow sands.